AFIT View of CCMC

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Outline

- What is AFIT?
- AFIT Space Physics Program
- Role of CCMC in AFIT Coursework
- Role of CCMC in AFIT Research

[www.afit.edu]

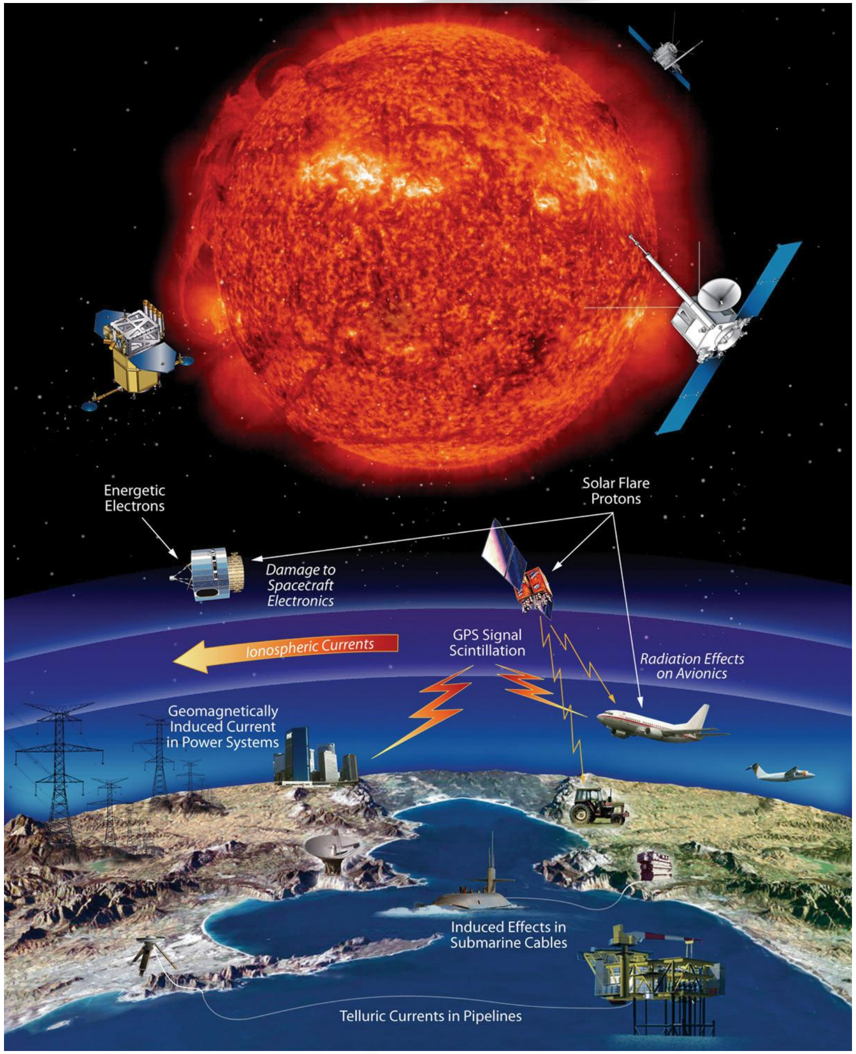
AFIT

- AFIT = Air Force Institute of Technology
- Graduate school for the Air Force
  - Awards both PhD and MS degrees
- Located at Wright Patterson Air Force Base, OH
- ~750 in-residence students
  - Mostly military but we have civilians and foreign officers too
  - Full time assignment for military students

[www.wpafb.af.mil/News/]

Space Physics Track

- MS Applied Physics program
- Primarily tied to Space Weather
  - Sun to Earth's ionosphere
    - "From Sun to mud"
    - "Solar system astrophysics"
- Two 15W students per year
  - MOA with AF Weather
  - 21-month program
  - 8FDD (Ionospheric Environment)
  - 8FDY (Solar and Space Sciences)
- And the occasional 61D student
  - 18-month program
  - 8HYY (General Physics)
  - 8HNY (Plasma Physics)
  - 8HOZ (Space Physics)

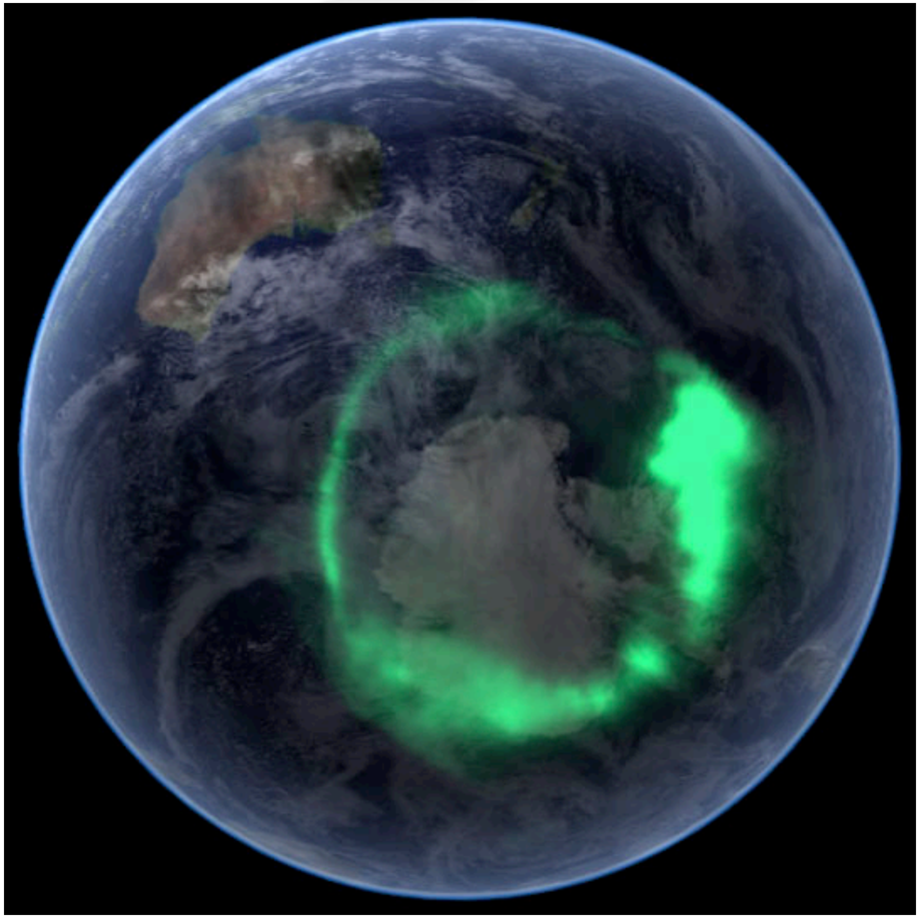


[www.nasa.gov/mission_pages/sunearth/spaceweather/]

Space Physics Curriculum

The AFIT of Today is the Air Force of Tomorrow.

- Physics Core
  - PHYS 601 (E&M)
  - PHYS 635 (Thermal)
- Other Prerequisites
  - PHYS 519 (Space Environment)
  - PHYS 650 (Plasma)
- Application Sequence
  - CHEM 675 (Ionosphere I)
  - PHYS 775 (Ionosphere II)
  - PHYS 776 (Magnetosphere)
  - PHYS 777 (Solar Atmosphere)
- Laboratory
  - PHYS 792 (Space Wx Lab)



[earthobservatory.nasa.gov/IOTD/]

Space Weather Lab/Field Trip

AFIT students visiting SWPC
30 Jan 2018
(photo by Jennifer Meehan)

- PHYS 792 – final quarter
  - Capstone lab course
  - Introduction to space weather forecasting and impact assessments
  - “Mini-thesis” – “70% solution” for another AF Weather topic
- Space Wx Field Trip
  - Final quarter (part of 792)
  - WI 2018 Field Trip
    - Space Weather Prediction Center (NOAA/SWPC)
    - High Altitude Observatory (UCAR/HAO)
    - Space Weather Operations Center (2WS/SpWOC)

Space Physics Graduates

- Where do the graduates of our Space Physics program go?
  - 557th Weather Wing Space Weather Operations Center (SpaceWOC)
  - NOAA Space Weather Prediction Center (SWPC)
  - Joint Space Operations Center (JSpOC)
  - Air Force Research Laboratory (AFRL)
  - Radio Solar Telescope Network (RSTN)

[www.af.mil]

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Role of CCMC in Coursework

AIR FORCE INSTITUTE OF TECHNOLOGY

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ModelWeb Catalogue and Archive

Community Coordinated Modeling Center (CCMC) | Goddard Space Flight Center

Instant Runs and Runs on Request

Options to run models and view results using online interface are now available on the CCMC website
CCMC Instant Runs
CCMC Runs on Request

Model Catalog and Archive:

Atmosphere models [info]

Density and Temperature Models

- Exospheric H Model [info, ftp]
- NRLMSISE-00 Model [info, **RUN** ftp, link]
- MSISE-90 Model [info, ftp, **RUN**]
- MSIS-86 Model [info, ftp]
- MET Model [info, ftp]
- CIRA: Thermosphere [info]
- CIRA: 0 km to 120 km [info, ftp]
- OLDER MODELS (pre-1985)

Wind Models

- Horizontal Wind Model (HWM) [info, ftp]

Ionosphere Models [info]

General Models

- Incoherent Scatter Radar Models [info]
- IRI [info, ftp, **RUN**]

Electron Density Models

- PIM Model [info]
- FAIM Model [info]

Gravitation/Geopotential Models

- Earth Gravitational Model 2008 (EGM2008) [info, link]

Geomagnetic(Main) Field Models [info]

General Models

- IGRF Model [ftp, info, link, **RUN**]

Miscellaneous Geomagnetic Field Models

- USGS Model Coefficients for Continental U.S. and Hawaii [info]
- GSFC Model Coefficients: All [ftp], (11/87) [info], (12/83) [info], (9/80) [info], (12/66) [info], (9/65) [info]
- Summary Table
- OLDER MODELS

Magnetospheric Field Models [info]

- Toffoletto-Hill Magnetosphere Model [link]
- Xu-Li Neutral Sheet Model [info, ftp]
- Tsyganenko Magnetic Field Models and GEOPACK routines [info, link, url]
- OLDER MODELS (pre-1979)

[ccmc.gsfc.nasa.gov/modelweb/]

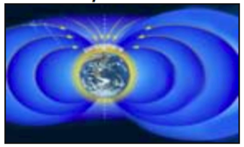
- For these complex topics, many assignments are project based
- CCMC provides a unique capability to run a variety of space weather models remotely
- Familiarity with the models is beneficial to student's future assignments

CCMC for Classwork: Example

- Ionosphere I
  - Run NRLMSISE-00 for neutral densities used in photoionization calculations
- Ionosphere II
  - Compare predictions from IRI, USU-GAIM, SAMI3, CTIPe, TIE-GCM, and GITM

Note: it would be extremely difficult to setup and maintain all of these models locally

IONOSPHERE/THERMOSPHERE



Ionosphere/Thermosphere:	
DTM	Sean Bruinsma
SAMI3	Joseph Huba, Glenn Joyce, Marc Swisdak
CTIPe	Timothy Fuller-Rowell et al
ABBYNormal	J. Vincent Eccles et al.
USU-GAIM	R.W. Schunk, L. Scherliess, J.J. Sojka, D.C. Thompson, L. Zhu
IRI	D. Bilitza, NASA/GSFC
Cosgrove-PF	Russel B. Cosgrove
Ovation Prime	Patrick Newell
TIE-GCM	R. G. Roble et al.
PBMOD	John M. Retterer
GITM	A.J. Ridley et al.

[ccmc.gsfc.nasa.gov/models/]

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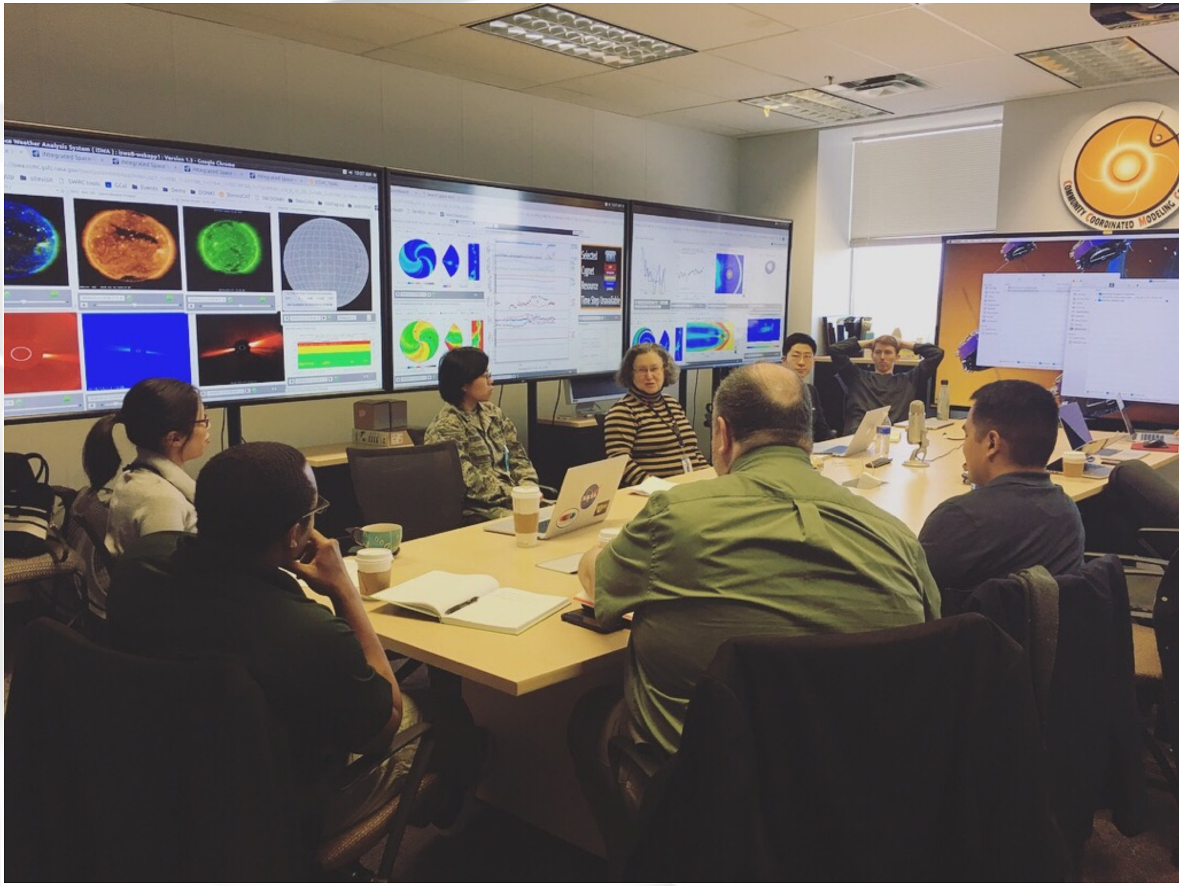
Role of CCMC in Research

- CCMC has sponsored several research efforts in the past
- The expertise, mentorship, and computational resources provided by CCMC are ideal for a thesis research project



SPACE WEATHER, VOL. 11, 95–106, doi:10.1002/swe.20019, 2013

Ensemble forecasting of coronal mass ejections using the WSA-ENLIL with CONED Model

D. Emmons,[1,2] A. Acebal,[1] A. Pulkkinen,[3,4] A. Taktakishvili,[3] P. MacNeice,[3] and D. Odstrcil[3,5]

Received 8 October 2012; revised 8 December 2012; accepted 14 December 2012; published 4 March 2013.

[1] The combination of the Wang-Sheeley-Arge (WSA) coronal model, ENLIL heliospherical model version 2.7, and CONED Model version 1.3 (WSA-ENLIL with CONED Model) was employed to form ensemble forecasts for 15 halo coronal mass ejections (halo CMEs). The input parameter distributions were formed from 100 sets of CME cone parameters derived from the CONED Model. The CONED Model used image processing along with the bootstrap approach to automatically calculate cone parameter distributions from SOHO/LASCO imagery based on techniques described by Pulkkinen et al. (2010). The input parameter distributions were used as input to WSA-ENLIL to calculate the temporal evolution of the CMEs, which were analyzed to determine the propagation times to the L_1 Lagrangian point and the maximum K_p indices due to the impact of the CMEs on the Earth's magnetosphere. The Newell et al. (2007) K_p index formula was employed to calculate the maximum K_p indices based on the predicted solar wind parameters near Earth assuming two magnetic field orientations: a completely southward magnetic field and a uniformly distributed clock-angle in the Newell et al. (2007) K_p index formula. The forecasts for 5 of the 15 events had accuracy such that the actual propagation time was within the ensemble average plus or minus one standard deviation. Using the completely southward magnetic field assumption, 10 of the 15 events contained the actual maximum K_p index within the range of the ensemble forecast, compared to 9 of the 15 events when using a uniformly distributed clock angle.

Citation: Emmons, D., A. Acebal, A. Pulkkinen, A. Taktakishvili, P. MacNeice, and D. Odstrcil (2013), Ensemble forecasting of coronal mass ejections using the WSA-ENLIL with CONED Model, *Space Weather*, 11, 95–106, doi:10.1002/swe.20019.

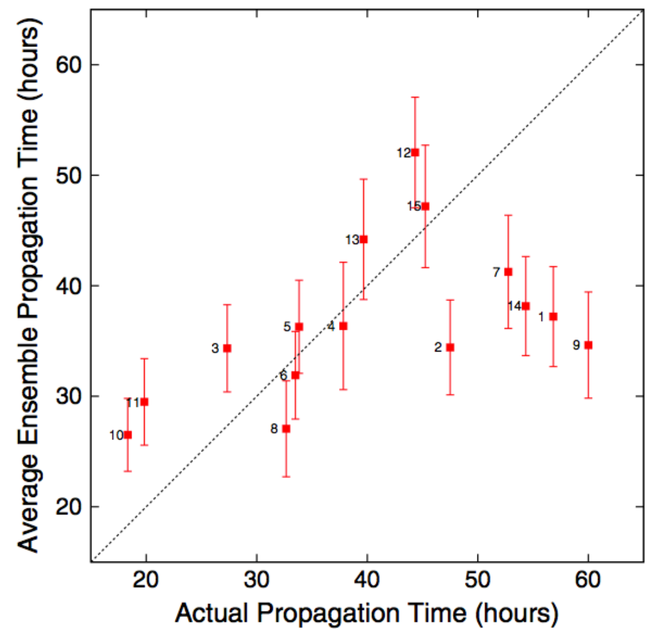


Figure 8. The averages and standard deviations of the propagation time ensembles versus the actual propagation times, with the event number as the label. The actual propagation time was within the average plus or minus one standard deviation for 5 of the 15 events.

CCMC for Research: Example

The AFIT of Today is the Air Force of Tomorrow.

Assessing predictive ability of three auroral precipitation models using DMSP energy flux

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[1]Department of Applied Physics, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, USA, [2]Space Weather Laboratory, NASA Goddard Space Flight Center, Greenbelt, Maryland, USA

Abstract Our study statistically compares the total energy flux outputs of Newell et al.'s (2010a) oval variation, assessment, tracking, intensity, and online nowcasting (OVATION) Prime model, Hardy et al.'s (1991) *Kp*-based model, and a coupled Space Weather Modeling Framework ring current model to energy flux data obtained from 2198 Defense Meteorological Satellite Program (DMSP) satellite passes in the Northern Hemisphere. Our DMSP data set includes 28 days grouped into continuous 3 and 4 day periods between 2000 and 2008 and encompasses magnetic local times (MLTs) between 04:00 and 21:00. We obtain the most equatorward magnetic latitude coordinate, where a DMSP satellite energy flux measurement exceeds 0.4 erg/cm^2/s, and use this point as a proxy for the equatorward boundary of the auroral oval in a particular MLT sector. We then calculate a prediction efficiency (PE) score by comparing the DMSP boundary coordinates to each model, using the same energy flux threshold to obtain a model's boundary location. We find that the PE for the OVATION Prime model is 0.55, and the PE for the Hardy *Kp* model is 0.51. When we accomplish the same analysis using a higher energy flux threshold equal to 0.6 erg/cm^2/s, the OVATION Prime model's PE increases to 0.58, while the Hardy *Kp* model's score drops to 0.41. Our results indicate that more complex modeling techniques, like those used in OVATION Prime, can more accurately model the auroral oval's equatorward boundary. However, Hardy's discretized *Kp* model, despite its relative simplicity, is still a competitive and viable modeling option.

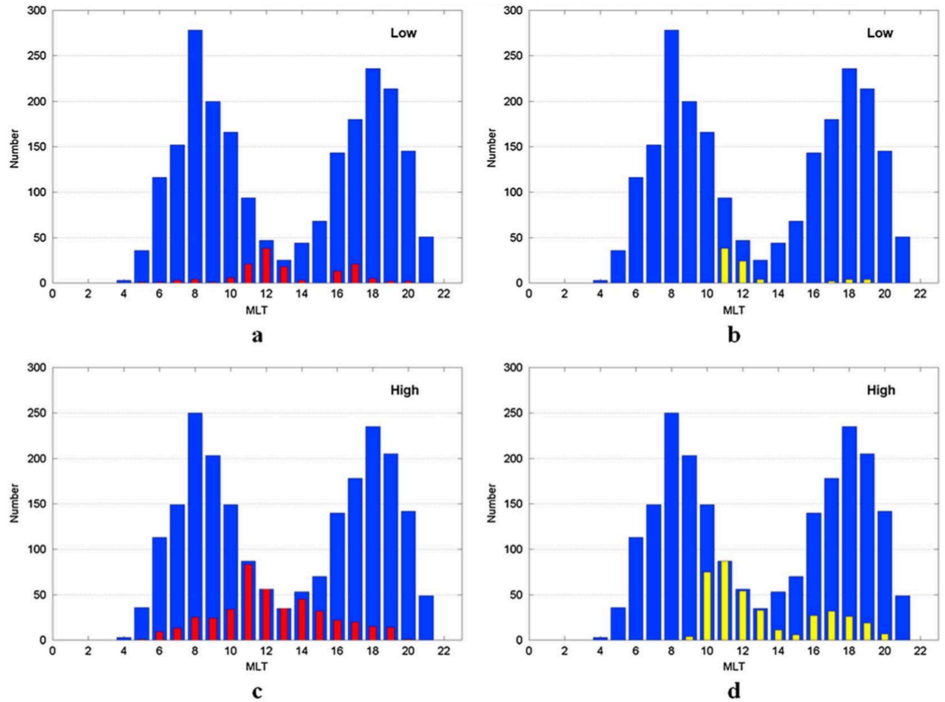

Figure 6. Distribution plot of (a) OH model and (b) OP model boundaries obtained in each MLT sector using 0.4 erg/cm^2/s ("low") threshold with the number of boundary misses overlaid. (c and d) Boundary misses using 0.6 erg/cm^2/s ("high") threshold are shown.

Future Collaboration

The AFIT of Today is the Air Force of Tomorrow.

- AFIT and CCMC met recently to discuss future research
- Several potential topics were provided, and a topic was selected for an incoming MS student
- AFIT provides students and unique Air Force experience/resources
- CCMC provides expertise and computational resources

Questions?

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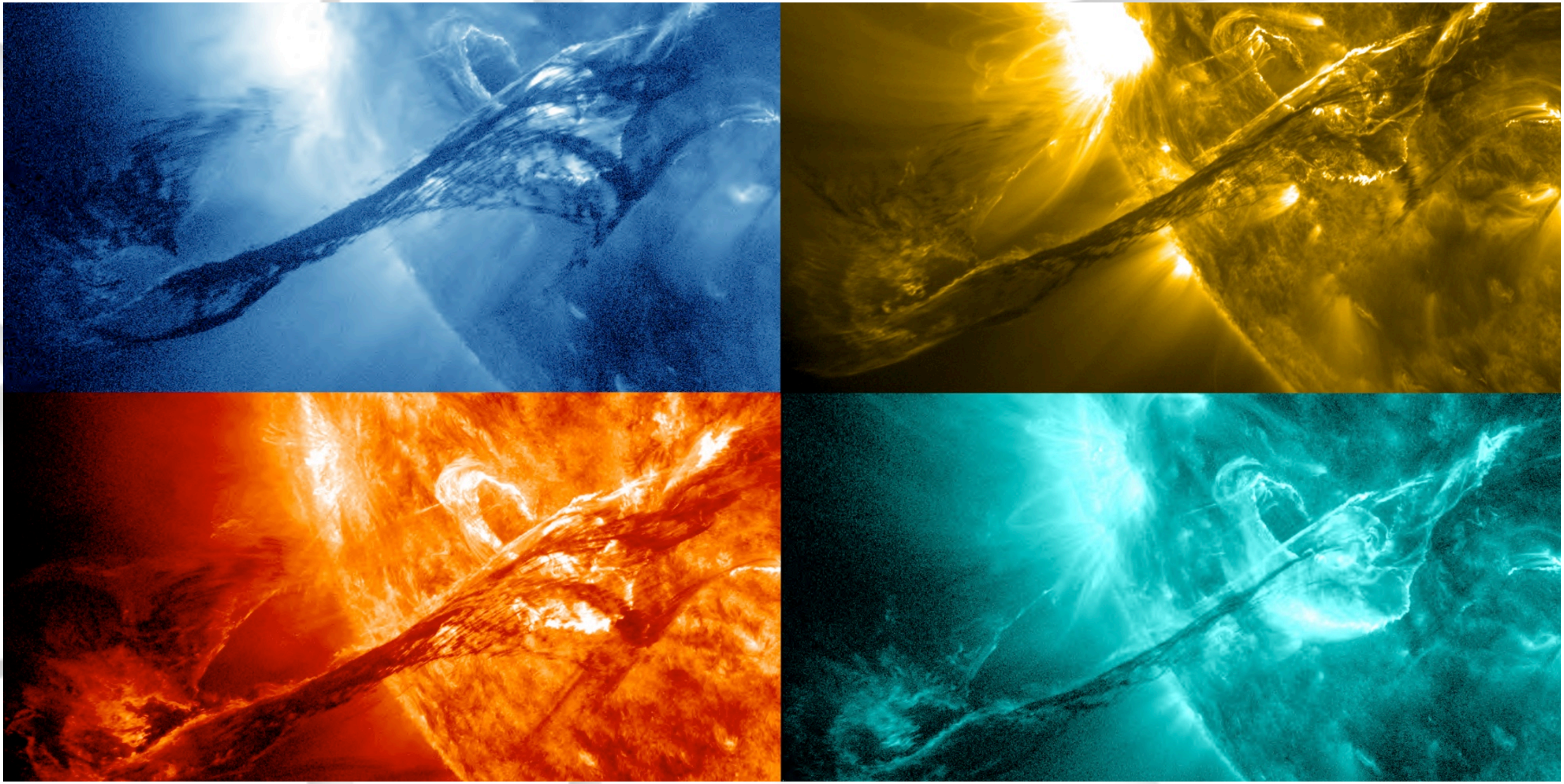

[svs.gsfc.nasa.gov/11095]